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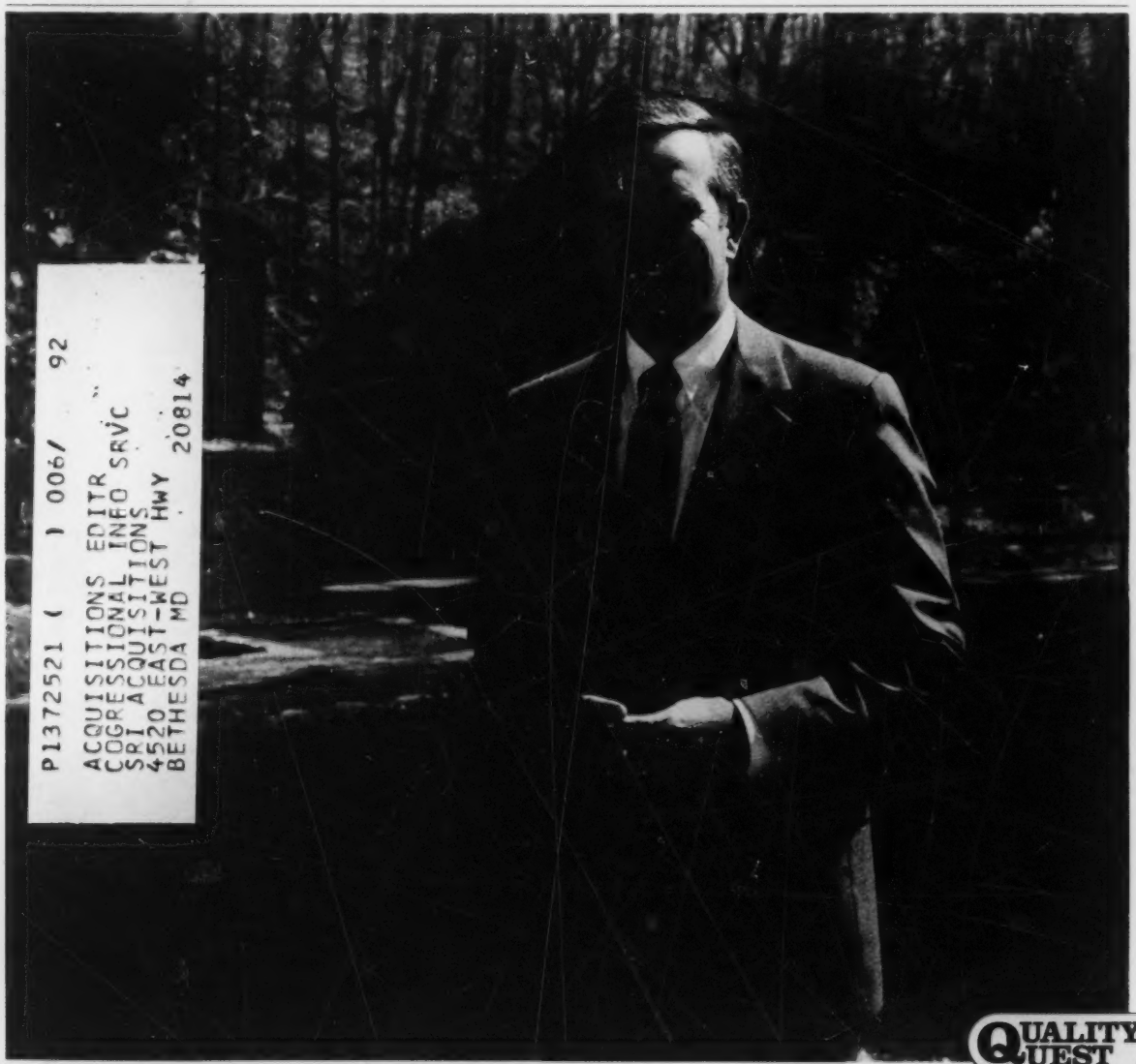
Electronic Business

CAE/CAD/CAM market shifts away from turnkey sales

Programmable controllers move toward a $5 billion business



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Du Pont's Henry: Spearheading a $1.3 billion electronics thrust

QUALITY QUEST

The secret behind DEC's product machine

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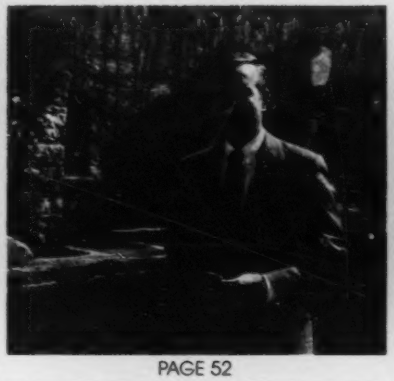
PAGE 30



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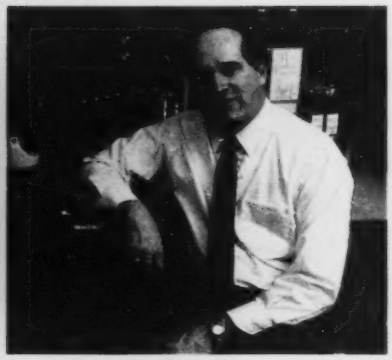

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Cover photo/Bill Fitch

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VBPA ABP

Passive component makers started 1987 actively

AVX gloats over lots of capacitance, but PCB shops suffer from lots of capacity

Marshall D. Butler claims that he accurately called the recent major turning points in the U.S. electronics business. He called it the first time in September 1984, when business turned down at the start of the longest recession that the U.S. market for electronic components had suffered in the past 30 years. Then, again in November 1986, for what he believes (and most forecasters now agree) was the beginning of the upturn from that recession.

The chairman of AVX Corp. attributes his accurate calls not to prescience but to product: multilayer ceramic capacitors, the tiny components that can pack a lot of capacitance in a small volume. As a leading manufacturer of MLCs — the largest in the world, according to Butler — AVX enjoys a privileged view of business conditions in the electronic component market which allows it to see the turning points faster than any other component maker. The reason, Butler is fond of explaining, is that the U.S. market for MLCs perfectly replicates the whole U.S. market for ICs. Large as they are, none of the IC makers has a share of the IC market as large as AVX has of the MLC market. Hence, his is a better view.

So far, Butler says, the view is very encouraging. AVX's sales for the first quarter of this year were 29% ahead of last year's. Besides, he adds, the company's first quarter was up 21% over the last quarter of 1986, making it two up quarters in a row. This is what he finds encouraging, because he sees it as reflecting actual demand. By comparison, there was only an ephemeral improvement last year when his customers had to replenish their depleted inventories. Back in 1985 and 1986, he says, AVX's customers were selling inventoried equipment they didn't have to make, or making equipment with inventoried capacitors they didn't have to buy.

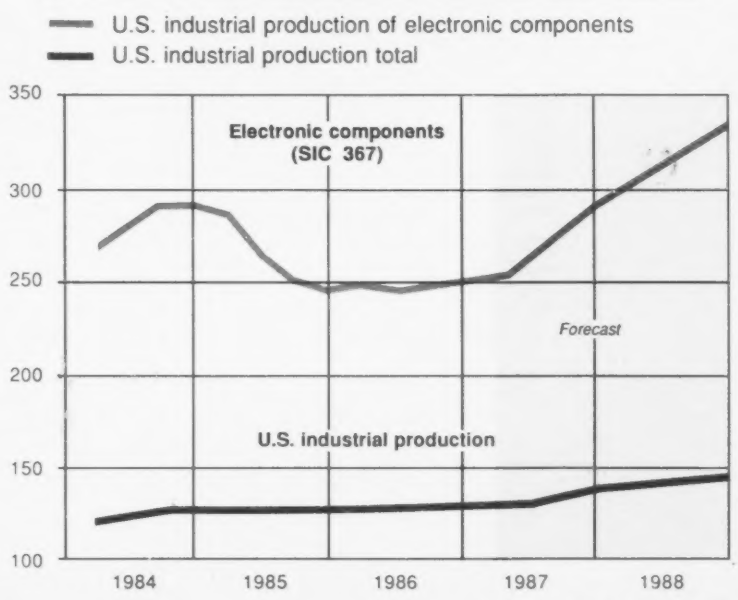
The official figures from the U.S. Department of Commerce are beginning to confirm Butler's optimism. After dropping 8% in 1985 and 6% in 1986, the industrial production index for electronic components (SIC 367) was up for the first quarter of this year by 3% over the same quarter in 1986. Even though this index is heavily influenced by semiconductor production, it is the only one that gives market watchers a glimpse of activity by manufacturers of components other than semiconductors (passive, electromechanical and interconnection components).

For example, for The Cherry Corp., an important manufacturer of switches for electronics applications (formerly known as Cherry Electrical Products Corp.) the first quarter was almost as good as for AVX, up 26% over last year's. Interconnection components also show strength, except for printed circuit boards which are still suffering from overcapacity among PCB makers, even among makers of multilayer boards. Cahners economist Cheryl Patstone forecasts that the industrial production index for SIC 367 will increase by 10% in 1987. This is good news for makers of passive components, just at the time when many are becoming orphans from the large parents that bought them in the past decade. TRW Inc. sold its capacitor factory and divested resistor maker IRC. The Penn Central Corp. is trying to divest Sprague Electric, the leading manufacturer of capacitors (of all types) in the United States, and Union Carbide Corp. still hasn't found a buyer for Kemet, which is AVX's strongest competitor.

ALBERTO SOCOLOVSKY

Electronic components

Industrial production indexes, 1977 = 100

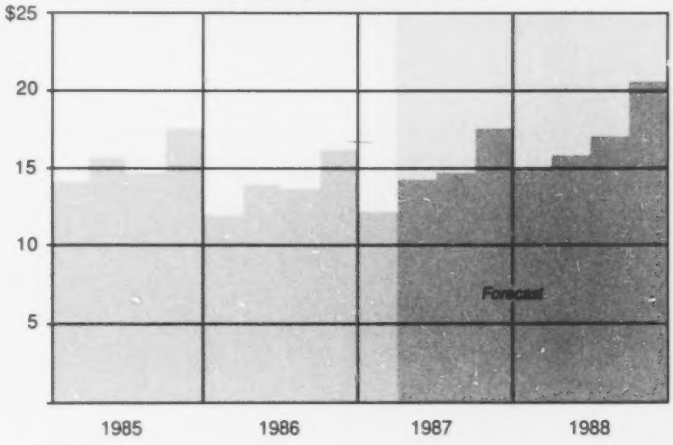


Historical data: Federal Reserve Board
Forecast: Cahners Economics

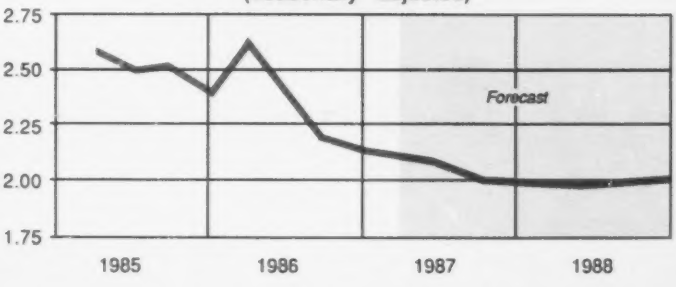
Office and computing equipment

(SIC 357)

Office and computing equipment: Shipments
(quarterly totals, $ billions)



Office and computing equipment: Inventory-to-shipment ratio
(seasonally adjusted)



Historical data: U.S. Department of Commerce
Forecast: Cahners Economics

New orders

In the fourth quarter of last year, manufacturers of computers and office machines received $15.71 billion in new orders, a decrease of 2.6% from the year-ago period, but up significantly from the third quarter's $13.33 billion. There was further evidence of a computer industry rebound in early 1987; preliminary reports show that orders rose modestly on a year-to-year basis (the first such gain since summer 1985). Rising foreign demand resulting from the weaker dollar, new product cycles and an upturn in domestic capital investment will join together to sustain the industry's current climb in 1987 and 1988. Orders, which fell 11.8% in 1986, are expected to rebound 11.4% this year.

Shipments

Although orders began to rise last summer and showed particularly encouraging results in early 1987, shipments have yet to improve substantially. During last year's fourth quarter, manufacturers shipped $16.27 billion worth of equipment, a seasonal increase over the third quarter's $13.74 billion, but down 8.2% compared with the year-ago quarter. Annually, shipments reached $56.23 billion, a 9.6% loss from the previous year. Shipments are expected to climb 5.2% this year, with most of the growth occurring in the second half of the year.

Unfilled orders

Manufacturers' order backlogs declined to $18.81 billion in the fourth quarter of 1986, their lowest level in more than three and a half years. This was the sixth consecutive period of decline. Early reports for the first quarter of 1987 indicate that backlogs will post another modest decrease. However, rising order rates should cause them to gradually increase over the remainder of the year. At the end of 1986, backlogs were running nearly 10% below the year-earlier level. By this December, they should be up more than 7%, with a further gain of 16.3% expected by year-end 1988.

Inventory-to-shipment ratio

The ratio of manufacturers' inventories to shipments fell slightly from 2.20 to 2.16 in the fourth quarter of 1986. This decrease was largely a reflection of ongoing cutbacks in the level of inventories, which were valued at approximately $10.07 billion in the final quarter, down from a peak of $13.59 billion at the start of 1985. Early data for this year's first quarter suggest that the I/S ratio will stabilize at about 2.15, implying that inventories have finally reached the desired balance with shipments. Although manufacturers may increase their inventory buffers over the next several months, we expect the ratio to remain fairly close to its present level throughout 1987.

Communication equipment

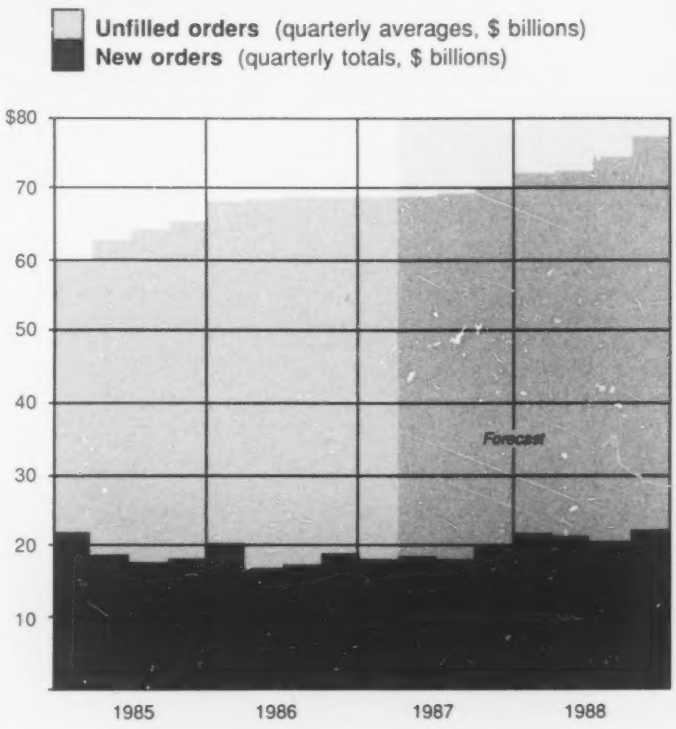
(SIC 366)

New orders
Communication equipment manufacturers received $18.94 billion worth of new orders in the fourth quarter of 1986, an increase of 4.4% over the year-ago quarter. But the degree of improvement was too small to prevent the year from posting a loss; orders totaled only $73.22 billion, down 3.6% from $75.97 billion in 1985. Demand for nondefense products (which comprise about half of the industry total) has recently begun to pick up after a protracted slump in 1985 and 1986. However, the positive effects of this turnaround will be dampened by a slackening in the military-communications area. The result will be a modest gain in orders of only 1.5% in 1987. A healthier increase of 15.3% is expected in 1988.

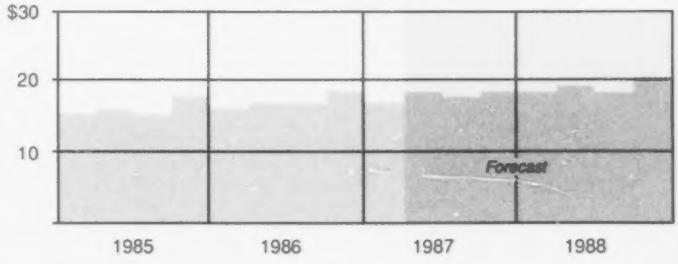
Shipments
Manufacturers shipped an estimated $19.14 billion worth of equipment in last year's fourth quarter, an increase of more than $2 billion over the traditionally slow summer quarter. For the year, shipments were up 6.6%. Carryover funding for military programs, which was the principal source of market growth last year, will provide far less stimulus in 1987. Shipments are expected to climb 4.9% in 1987, reaching a total of $73.13 billion. In 1988, a pickup in the nondefense industries will bring increased business investment, causing growth to improve at an 8.2% rate.

Unfilled orders
Order backlogs in the communication equipment industry reached a fourth-quarter average of $69.35 billion, an increase of just 0.2% compared with the third quarter. More important, year-end backlogs stood merely 5.3% ahead of the previous December's level. Projections for modest increases in both orders and shipments in 1987 suggest that backlogs are in for a relatively flat year, probably growing 1% to 2% annually. The gain in 1988 will be much stronger, although still lackluster by recent standards. Backlogs should grow to $77.6 billion by next December, up approximately 10% from the end of this year.

Inventory-to-shipment ratio
The ratio of manufacturers' inventories to shipments averaged 2.57 in the fourth quarter of 1986, down from 2.94 in the preceding quarter. This decrease was caused largely by a reduction of more than $400 million in inventories between August and December of last year. Manufacturers will have little incentive to build inventory cushions this year if growth turns out to be as modest as expected. Thus, the I/S ratio should stay within a tightly controlled range of 2.5 to 2.8 throughout 1987 and into the first half of 1988.



Communication equipment: Shipments
(quarterly totals, $ billions)



Communication equipment: Inventory-to-shipment ratio
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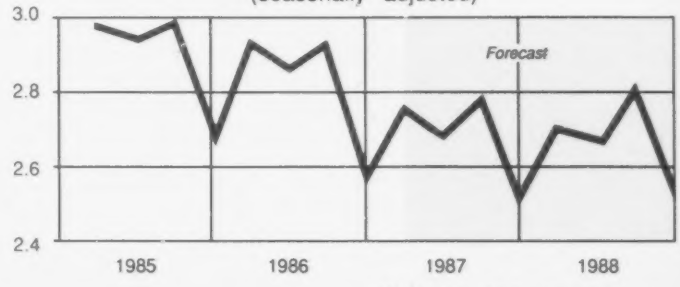


Historical data: U.S. Department of Commerce
Forecast: Cahners Economics

Programmable controllers move toward a $5 billion business

Despite a sluggish 1987, controllers will post strong growth; but not without standardization

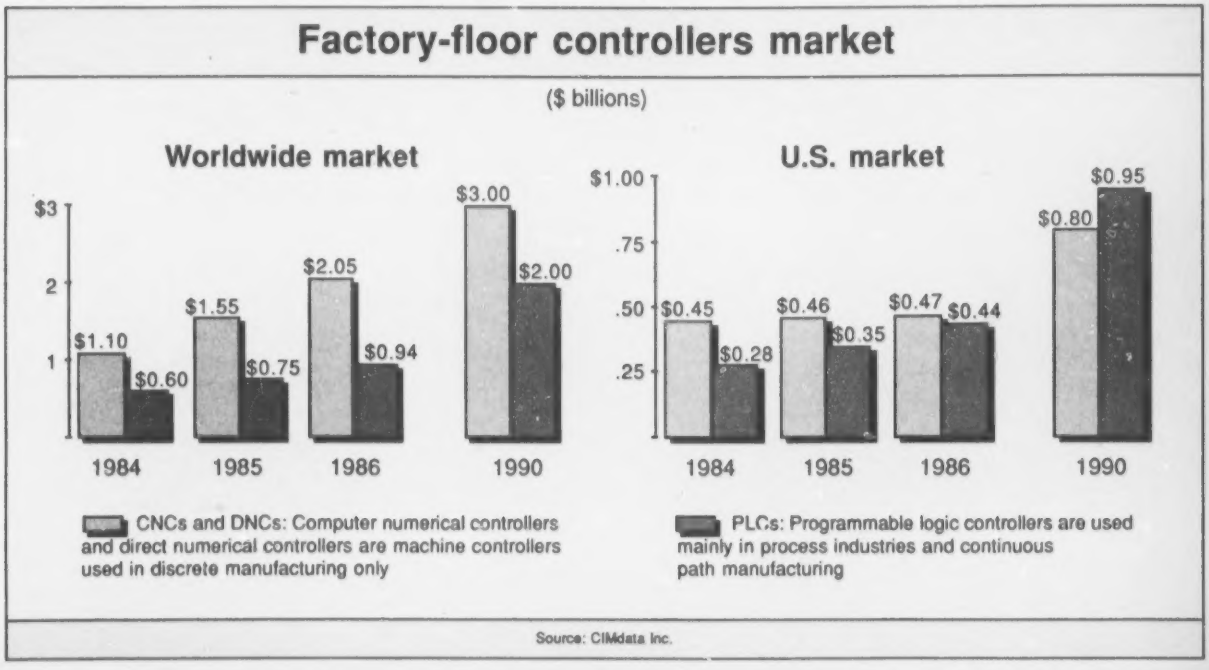
A primary goal in the $940 million worldwide programmable controller market is to make tomorrow's factory of the future today's reality. The idea is to link the factory floor — the domain of programmable controllers — to the corporate communication network in order to improve productivity and usher in the age of a truly computer-integrated manufacturing (CIM) environment. This is easier said than done. But, as controllers become more sophisticated, the leading vendors are poised to capture their share of the growing factory automation market.

Currently, there is confusion on the shop floor. It is tough to link vendors' equipment together to create a truly CIM environment when the equipment talks different languages. This confusion is contributing to the slow growth, forecast at between 0% and 5%, for programmable controllers in 1987. But, vendors and analysts agree, it is only a short-term dip in a business with promising long-term prospects.

The programmable controller market will hum along at close to a 20% clip through the end of the decade, says Julius Dorfman, president of CIMdata Inc., a Wellesley Hills, Massachusetts-based consulting and CIM market services firm. The U.S. market for programmable controllers accounts for almost half of the total worldwide market and will grow from $440 million in 1986 to $950 million by 1990, predicts Dorfman. Others, however, put the market figures at closer to $600 million for 1986. But, despite this disparity, most industry experts agree that by 1992 the domestic industry will be over $1 billion.

Programmable controllers were initially designed as replacements of electromechanical relays back in the early 1970s. And, like the personal computer that has radically changed the office environment, programmable controllers have done a lot to change the factory environment. Because they are the first level of factory automation, programmable controllers play a crucial role in the CIM environment. The attention by vendors has been on upward integration of these black boxes. Today, many programmable controller vendors are in the cell controller market — units that control clusters of programmable controllers — as well as the industrial computer market.

But this bottom-up strategy has competition. The consultants and systems integrators that are preaching the wonders of CIM prefer the top-down strategic approach. That is, tackling the issue of automation from the executive suite and fitting the factory into the corporate framework. The trick is to assimilate these two schools of thought. There is the vague expectation that the top-down and bottom-up camps will meet some-



where in the middle.

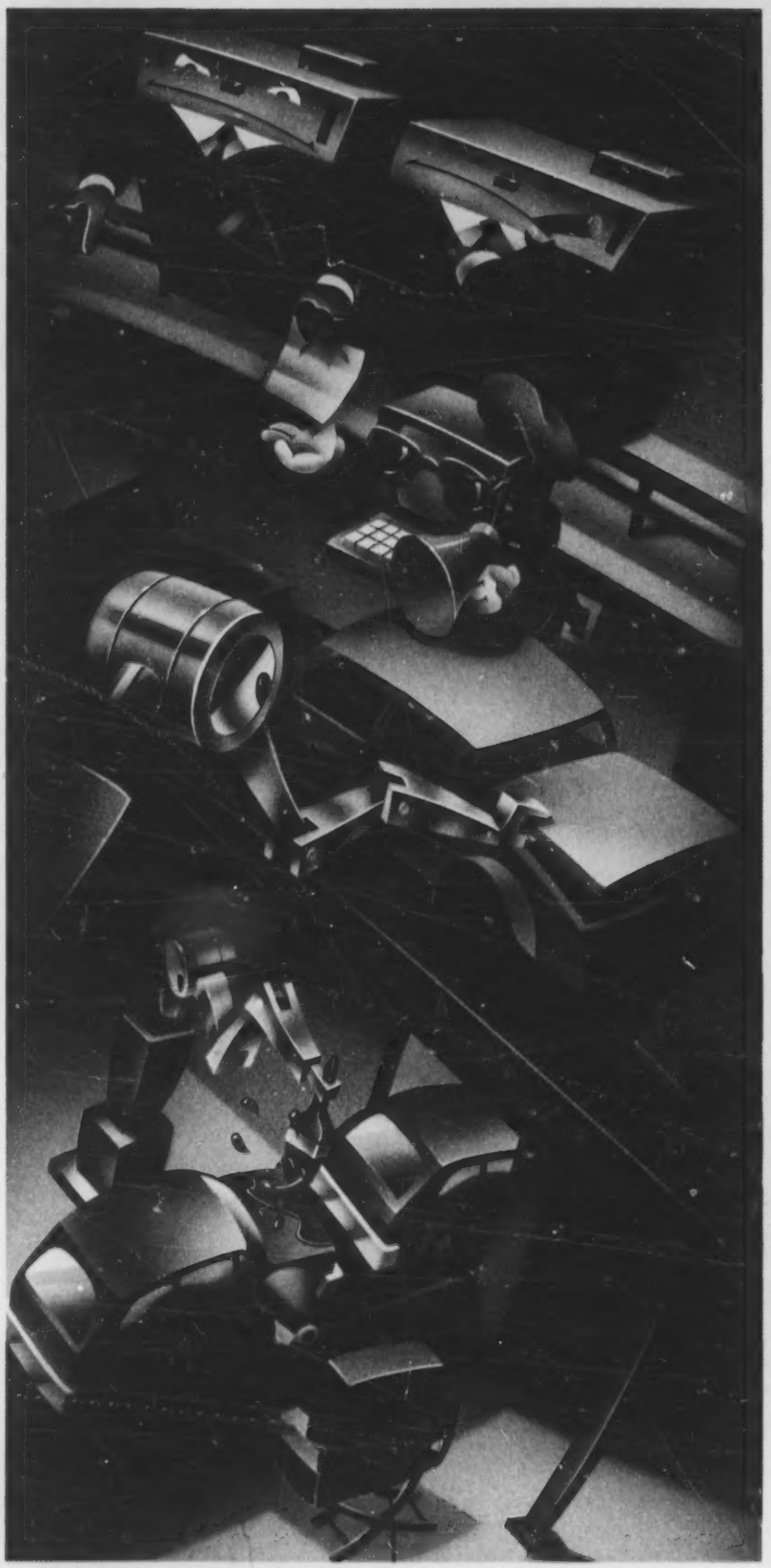
George Dancu, a management consulting services partner in the Pittsburgh office of Coopers & Lybrand, a Big Eight accounting firm that does top-down consulting, believes that the factory automation market will reach $50 billion by the early 1990s. He stresses the necessity for the corporate office and the factory floor to reconcile the top-down and bottom-up philosophies. Without reconciliation and standardization, that $50 billion market will be much smaller. This middle ground — the cell controller and industrial computer market — is where the money is to be had. The factory of the future, says Dancu, will be built by a multitude of vendors as no one vendor can satisfy all of the requirements.

Controlling factors

Much of the expected growth in the programmable controllers market is dependent on factors beyond the control of vendors. At the top of the list is the general health of the U.S. automotive industry — a major customer of programmable controllers — that is in the throes of more shutdowns and layoffs. In 1985, the automotive industry spent $5 billion on factory automation, $255 million of which was for programmable controllers, reports Arthur D. Little Inc., a Boston-based research and consulting firm.

Another factor in the growth equation is the increasing competition in the U.S. market from Japanese vendors. Many U.S. controller companies now buy low-end microprogrammable controllers from Japanese producers and are also looking to form strategic alliances where possible. The leading Japanese computer numerical control company, Fanuc Ltd., established a joint venture with General Electric Co. earlier this year [ELECTRONIC BUSINESS, March 15, 1987 p32].

But, some Japanese programmable controller companies are not so sure they want to team up with American vendors. Mitsubishi Electric Sales America Inc., a top programmable controller maker wants to go it alone in its penetration of the American market, says Robert Sore, New England area manager for the company. He claims that Mitsubishi has had repeated offers from major U.S. factory automation companies, but it has declined all joint-venture offers. Mitsubishi has been in the United States for four years, Sore says, and has



Dana Joly

Programmable controllers will link the factory floor to the corporate communication network

broadened its product offering to include not only microprogrammable controllers but also medium- and high-end units.

Competition is also fierce from West Germany's Siemens AG and the U.S. subsidiary, Seimens Energy and Automation Inc. In its attempt to capture a portion of the small-unit market away from the Japanese, Siemens recently unveiled a new line of low-end products. The reason, says Raymond Leveille, vice president and general manager of the programmable controls division for Siemens' American company, is because of the expected decline in demand for the larger programmable controllers.

Besides the competition and the ailing health of segments of smokestack America, there is the nagging issue of when a universally accepted communication protocol will take hold in the factory automation marketplace. Manufacturing automation protocol (MAP) is widely endorsed by domestic and international standards boards as well as a growing number of vendors, but it is still not widely used. In Britain it is virtually nonexistent and it is just now getting a toehold in the European continent. There is even dissension in the U.S. ranks as to MAP's viability. As a result, vendors have their own proprietary systems and are aggressively pushing them both domestically and internationally.

It is in the international marketplace that the strongest growth for factory automation exists. The need for domestic programmable controller vendors to become world-class players is vitally important for their long-term staying power and their ability to capture international business. Predictably, Asia is looked at as the hottest market right now.

The 50-50, $200 million GE-Fanuc joint venture puts this third-ranked programmable controller company in a very good position to milk the Far Eastern market. Robert P. Collins, chief executive of GE-Fanuc, North America Automation, claims that the Asian market for programmable controllers will grow at over 25% for the next five years. Europe will post growth rates averaging between 5% and 10%, while America will show static or slow growth for the same five-year period, he predicts. Collins insists that a global market strategy is the only way to access the world marketplace.

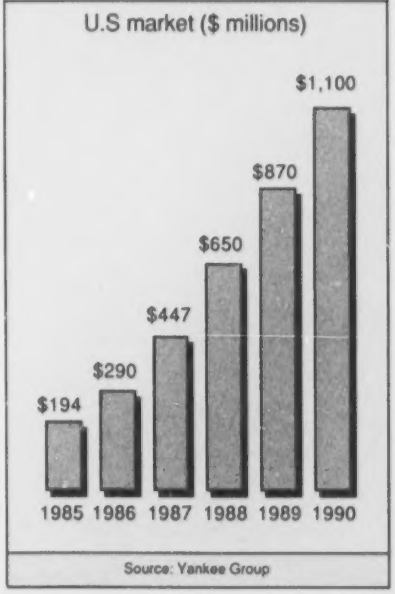
Fifth-ranked Square D Co., the low-profile programmable controller company headquartered in Palatine, Ill., is attempting to spruce up its operation by injecting some new blood into its organization. Jerre L. Stead, president and chief operating officer since January of this year, joins Square D from Honeywell Inc. and intends to turn the stodgy manufacturer into a world-class player. With only 15% of the company's business conducted overseas, Stead says that he is looking to establish a relationship with a Far East company before the end of the year. Similarly, Europe offers Square D a "tremendous growth potential," he adds.

World-class status combined with a broader product offering is also the intention of top-ranked Allen-Bradley

One Asian market that few programmable controller makers are overlooking is the emerging Chinese market. As a new wave of industrialization takes hold, most leading firms are ensuring that they have some presence in China and are looking to grow that presence in the future. Second-ranked Gould Electronics has been producing programmable controllers in China under a licensing agreement since 1984. The contract is for 10 years and is valued at $12 million or more, the company reports.

Similarly, Texas Instruments Inc., the fourth-ranked programmable controller vendor, has equipment in over 250 Chinese sites, claims M. Mac McDonnell, vice president of TI's industrial systems division, based in Johnson City, Tenn. TI has been in the business since the late 1970s and has dedicated salespeople in Australia, China, Japan, Korea, Singapore and Taiwan, McDonnell says. The company's goal for 1987 is to become a world-class manufacturer and it is planning on a year of growth, despite the expectations of a flat market, adds McDonnell. He claims that TI's share of the market grew in 1986 as a result of the move in 1984 to broaden the product offering. The company is at loggerheads with GE-Fanuc over the No. 3 position.

Cell controllers: The missing link and the new frontier



Allen-Bradley's strategy

World-class status combined with a broader product offering is also the intention of top-ranked Allen-Bradley Co. With between 40% and 50% of the programmable controller market, the Rockwell International company is aggressively pursuing a position as the one-stop factory automation shop through its five-layer "Productivity Pyramid" concept of factory integration. The glue that bonds these levels of computer control is the communication network and Allen-Bradley believes it has all of the communication permutations covered. According to Richard Ryan, director for marketing at AB's communication division, the communication system in the factory of the future will not be one single protocol. Instead, he argues, it will include the best elements of proprietary networks, MAP, Digital Equipment Corp.'s EtherNET and possibly other protocols.

Ryan speculates that in a typical CIM environment, AB's proprietary baseband local area network — known as Data Highway — will be used for the factory floor, while MAP will be used to link programmable controllers to the factory-wide computer. From this level up, an EtherNET link will tie the factory to the office network. AB has products that can satisfy the needs of all of these levels of communication. The market leader recently signed an agreement with IBM to market Big Blue's 7552 industrial computer as the AB 6122 industrial support computer. With AB

software, this system monitors programmable controllers through the Data Highway carrier band.

In the shadow of the powerful Allen-Bradley, second-place Gould has been losing market share over the past few years. But, now with new product offerings, the company is trying to put its house back in order. It is estimated that AB and Gould together control between 60% and 70% of the programmable controller market.

Charles Downey Jr., Gould's vice president for marketing with the industrial automation systems division, admits that the company missed the shift in the marketplace earlier in the decade when demand was growing for systems solutions. Gould persisted in making black boxes — albeit good black boxes — but they were not what industry was buying, says Downey. Specifically, demand was on the rise for cell controllers, the second level of intelligence up from the factory floor. Gould now offers cell controllers, industrial computers, and a range of systems integration and software services. These include its own proprietary communication standard for its range of controllers as well as MAP.

Keith Belton, an analyst at the Boston-based Yankee Group, claims the cell controller market is a critical link in a CIM framework. Total U.S. sales for the cell control market in 1986 were $290 million and will grow at a rate of 54% this year, Belton says. By 1990, cell controllers will break the $1 billion mark, he predicts.

Because the cell controller is the second level of intelligence in the bottom-up integration strategy, the market is attracting interest from more than just the traditional programmable controller vendors. DEC, Hewlett-Packard Co. and IBM are all in the running with their own ruggedized boxes, as are the traditional players. Between the cell controller and the programmable controller, communication is not a problem. It becomes an issue, however, when the cell controller attempts to communicate upward with the factory-wide MRP or the corporate-wide MIS system.

What is clear is that without some degree of standardization, CIM will continue to be only a pipe dream

Filling a void

William Rolland, manager for industrial automation at the National Electrical Manufacturers Association (NEMA), sees cell controllers filling the void between the factory floor and the corporate computer system: but, only if a standard exists. Together with the Geneva-based International Electrotechnical Commission (IEC), NEMA is pushing to get the MAP standard approved. (MAP 3.0, the first truly multivendor protocol, will not be out until mid-1988.) A standard is crucial, Roland says, because no one vendor can provide all of the products and services needed to create a CIM facility. "They all have to depend on each other," he adds.

Connectivity and communication challenges also exist below the MAP level. This is part of the growing trend toward a more distributed control architecture in the factory whereby more complex functions are carried out closer and closer to the factory floor. This relieves the programmable controllers from performing unnecessary tasks. Ann Courtright, director for research in the manufacturing automation division of the Yankee Group, sees distributed control as a major trend in flexible manufacturing.

In a 1986 factory automation survey conducted by the Yankee Group, 15% of the respondents indicated that they were considering using microcontrollers to replace some programmable controller functions as the link to machine sensors. Courtright believes there is a need for a generic communication bus for the level below MAP — between sensors and microcontrollers — and names Intel Corp. as a company at the forefront on the road to standardization.

In 1984, Intel introduced the Bitbus interconnect, a serial bus that provides a standard method for connecting microcontrollers using serial communication. It is the only generic bus on the market and allows for low-cost communication across the factory floor and improves throughput, an Intel spokesperson says.

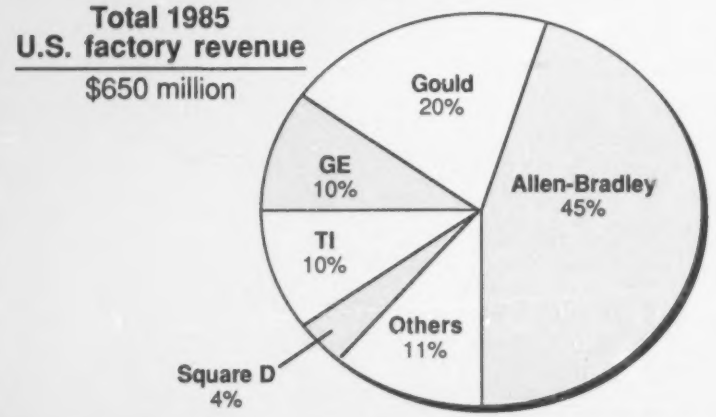
Despite its appeal, there are serious hurdles to overcome in the adoption of a standardized serial bus like Bitbus, Courtright says. The main problem is that the architecture of the factory-floor communication network is so firmly entrenched. The automotive industry, where the bulk of programmable controllers are used, will continue to use programmable controllers in the roles that they were traditionally built for, she says.

But, overcoming entrenched methods in manufacturing is the name of the game whether it is in terms of upward integration or downward integration of programmable controllers. What is clear is that without some degree of standardization, CIM will continue to be only a pipe dream.

BRUCE C.P. RAYNER

The top five programmable controller vendors

1985 U.S market share



Source: Dataquest Inc.

Unrest in the CAE/CAD/CAM industry

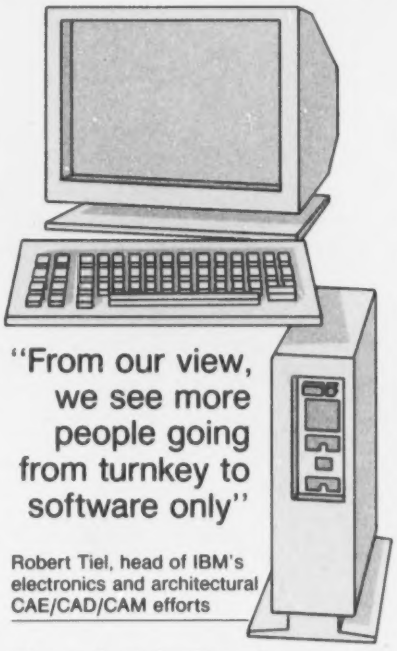
CAE/CAD/CAM vendors are busy revamping their business plans. Reason: The market is shifting away from turnkey sales

By Alden M. Hayashi

Industries that start off as turnkey often do not stay that way. Word processing is a classic example. Although word processors were initially sold as complete turnkey systems comprised of both computer hardware and software, they are rarely sold that way today. The same thing may be happening to CAE/CAD/CAM (computer-aided engineering/design/manufacturing), systems that help users automate the design, test and manufacture of products as diverse as computer chips, airplanes and skyscrapers.

Several signs that CAE/CAD/CAM is headed away from being a turnkey business have already surfaced:

- Due to customers' demands for name-brand computers, most CAE/CAD/CAM vendors have stopped making their own proprietary computers and have instead begun using hardware from such companies as IBM and Digital Equipment Corp. (DEC). The CAE/CAD/CAM vendors buy the generic computers, combine them with homemade software and then sell the resulting systems as turnkey products. But many vendors have subsequently gone one step further by selling at least pieces of their software separate, or "unbundled" as the industry's lingo goes, from the generic hardware. Consequently, some customers have begun to buy hardware directly from the computer companies and software separately from the CAE/CAD/CAM vendors. "Unbundled software is definitely catching on," says Charles M. Foundyller, president of Daratech Inc., a market research firm located in Cambridge, Mass.
- DEC further nudged the industry away from turnkey status last year when it changed some of its discount rates and made them the same for both volume end user and CAE/CAD/CAM vendor. The action made it cheaper for certain end users to buy the hardware straight from DEC and the software unbundled from the CAE/CAD/CAM company.
- And in the low end of the market, some CAE/CAD/CAM software has turned into a commodity mail-order business.



"From our view, we see more people going from turnkey to software only"

Robert Tiel, head of IBM's electronics and architectural CAE/CAD/CAM efforts

Many CAE/CAD/CAM vendors have noticed this trend away from turnkey sales and are revamping their strategies accordingly. Some companies are trying to make up for any anticipated loss in computer hardware revenue by selling more of something else. McDonnell Douglas Corp. is pushing its consulting services and proprietary value-added network. Daisy Systems Corp. sees a great future in homemade application-specific hardware that works in conjunction with the brand-name computers bought from the outside.

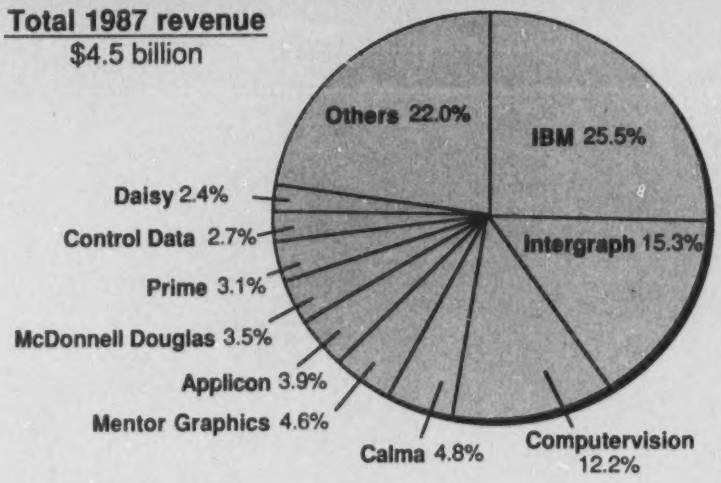
On the other hand, some vendors are bucking the trend. Although Computervision Corp. is now using generic computers bought from the outside, the company customizes some of the hardware so that end users must buy it from CV. Intergraph Corp. is going against the current industry wisdom that dictates using name-brand computers. The company instead is building its own proprietary workstation, forcing customers to buy the new Intergraph systems turnkey.

CV and Intergraph notwithstanding, some in the industry assert that the market's move away from turnkey sales will continue. The Technology Research Group of Boston estimates the percentage of supermicrocomputer workstations shipped turnkey in the electronics CAE/CAD/CAM market dropped from virtually 100% four years ago to 80% last year. TRG predicts the figure will plunge to 36% by 1990.

"From our view, we see more people going from turnkey to software only," says Robert P. Tiel, head of IBM's electronics and architectural/engineering/construction CAE/CAD/CAM efforts. "I think it's a reality," agrees Bill Green, manager of OEM (original equipment manufacturer) marketing for Apollo Computer Inc., a leading workstation manufacturer located in Chelmsford, Mass.

If this trend does indeed continue, it would make the CAE/CAD/CAM companies vulnerable to huge drops in sales. With Intergraph, 80% of sales are in hardware, according to president James Meadlock. Adds IBM's Tiel, "Certainly the bulk of our sales are hardware."

The top 10 CAE/CAD/CAM vendors



Source: Daratech Inc.

By selling both hardware and software, Intergraph and Computervision, respectively the No. 2 and No. 3 vendors in the industry, swept into the elite ranks of the *Fortune* 500. In contrast, software-only giants Cullinet Software Inc., Lotus Development Corp. and Microsoft Corp. did not. Says Intergraph's Meadlock: "I'm not terribly interested in being just a software company."

Neither is Gerard H. Langeler, executive vice president of Mentor Graphics Corp. of Beaverton, Ore. "There isn't an example of a software-only supplier in this industry that has ever been successful," notes Langeler. He explains that without the additional revenue garnered from hardware sales, research and development budgets would suffer. Bruce M. Holland, president of electronics CAE/CAD/CAM vendor Cadnetix Corp. of Boulder, Colo., agrees: "It takes enormous R&D to develop this kind of software and sometimes it's difficult maintaining the value in a software-only context." Consequently, Langeler says, "We believe very strongly that if the industry goes to software only . . . it would suffer and ultimately the customers would suffer."

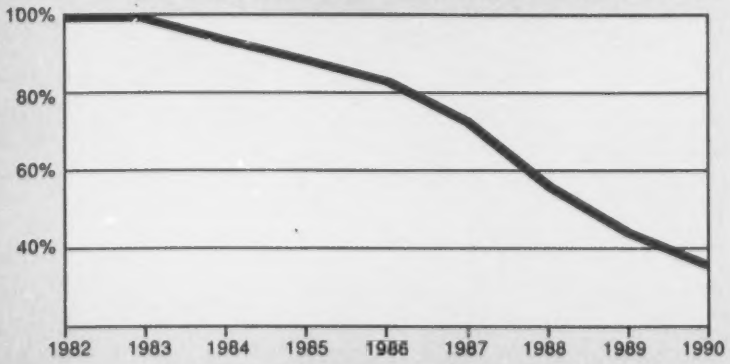
Furthermore, Mentor president Thomas H. Bruggere points to another danger of becoming a software-only company. Currently, Bruggere explains, the CAE/CAD/CAM companies have control over their customers' accounts. But if they were to become exclusively software companies, they would lose that control to the hardware manufacturers, asserts Bruggere. So instead of being the first one through the customer's door, the CAE/CAD/CAM vendor would have to follow the hardware vendor, and possibly other CAE/CAD/CAM vendors, he says.

The industry's trend away from turnkey sales has caused some competitive friction between the computer manufacturers and their CAE/CAD/CAM OEMs — companies that purchase hardware from the computer manufacturers, combine it with homemade software and then sell the turnkey products to end users. Says Ray J. Thackeray, a marketing manager for DEC: "We've heard of other computer companies' sales reps trying to sell hardware to the end user in competition with the OEM." Mentor's Langeler adds, "There are certainly some large customers who, from a purchasing standpoint, want to play the hardware vendor and the CAE vendor against each other and try to get the best possible price."

Not surprisingly, the heretofore peaceful OEM symbiosis between computer manufacturer and CAE/CAD/CAM vendor has lately become strained. "There is definitely unrest out there," says Daratech's Foundyller.

The move away from turnkey systems

Share of supermicrocomputer workstations shipped as turnkey systems in the electronics CAE/CAD/CAM market



Source: The Technology Research Group

A love-hate relationship

DEC did not help matters when it lowered its OEM discount rates last year, making them the same for volume end users of certain computers. Clearly the change did not please Intergraph's Meadlock [ELECTRONIC BUSINESS Nov. 15 p50] who is one of DEC's largest OEMs. "We have this love-hate relationship with DEC," says Meadlock. "If we're competing for an account, . . . then we're the heavy. But if we're competing against IBM, they love us."

This love-hate relationship may have been one of the reasons Intergraph made a gutsy decision to build its own computer instead of being an OEM of DEC's workstations. Although Meadlock is discreet about the whole matter, he implies that making money by being an OEM of DEC's hardware has lately become difficult. When asked why he decided to pump valuable resources into building hard-

ware instead of concentrating on Intergraph's strength in applications software, Meadlock replied: "Granted, it's a difficult thing to do.... But if we didn't do it, we won't be here to talk about it next year."

DEC has since made its OEM discount rates more favorable as of last March, but many OEMs still remain wary. In various interviews, DEC president Kenneth H. Olsen has said that he is tired of OEMs getting somewhat of a free ride from computer hardware manufacturers such as DEC. But, for the record, DEC insists that it still highly values its OEM business. "All of our OEMs should be making a profit using Digital Equipment as their platform of choice. Our strategy with OEMs is, we need them and we are aggressively trying to strengthen our relationships with them," says DEC's Thackeray.

Still, actions speak louder than words and DEC's actions over the past 18 months have not been comforting to the company's OEMs. "I met with DEC recently and told them: 'I can't do business like this and survive,'" says W. Douglas Hajjar, president of Valid Logic Systems Inc., a DEC OEM located in San Jose, Calif. According to Hajjar, Valid has been losing sales to DEC. Because of lower discount rates, some customers are beginning to buy DEC hardware directly from DEC instead of through Valid, he says. "DEC is costing us probably $3 [million] to $4 million a quarter in revenue .... That has to change." Adds Jerry J. Robertson, marketing vice president of Applicon Inc., a DEC OEM located in Ann Arbor, Mich.: "I do believe that DEC has lost contact with its OEMs."

INTERGRAPH's MEADLOCK: "I'm not terribly interested in being just a software company"

Different strategies

The CAE/CAD/CAM vendors, however, have not lost contact with their market. Most of them have revamped their business plans, some in deference to the trend away from turnkey sales, some in defiance of it. "Our model is shifting now to more software. We've seen that already and our plans are in that direction," says John J. Clancy, president of the Manufacturing and Engineering Systems Co. of McDonnell Douglas, headquartered in St. Louis.

As an OEM of IBM's hardware, McDonnell Douglas has had difficulty competing against IBM's hardware salesforce. "When you start selling IBM 4300 size machines in competition with IBM, you've really got your hands full," says Clancy. According to him, McDonnell Douglas plans to make up any lost revenue in hardware sales by leveraging other products such as the company's professional consulting services and its proprietary value-added network which links an end user to its suppliers and customers.

Applicon is also currently rethinking its strategy. An OEM of DEC, IBM and Sun Microsystems Inc. hardware, Applicon is starting to unbundle its software. "The software is where we make the money. The hardware — we cover the cost. We make enough money to pay the light bill," says Robertson, marketing vice president. The company also licenses its software to other vendors, making money marginally, according to Robertson.

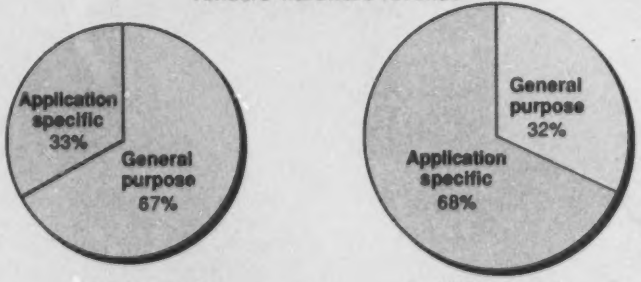
Daisy, of Mountain View, Calif., has also recently begun to unbundle some of its software. The company is hoping that an anticipated increase in the unit volume of software sales will offset the loss of hardware sales. According to director of marketing Robert Moore, Daisy is also counting on selling consulting services and a greater volume of application specific hardware such as accelerators and physical modelers. "There are tremendous opportunities there," he claims. TRG's market figures concur: For electronics CAE/CAD alone, the market for application-specific hardware will grow from $60 million in 1985 to $537 million in 1990.

Calma, a General Electric Co. subsidiary, sees itself turning into more of a software and services company, according to senior vice president Bruce Gregory. "One way in which we would expect our revenue to shift is toward a more effective full line of services — training, consulting, applications assistance and support," says Gregory. He claims, "Although the industry is clearly moving to a software focus, customers will continue to look for a full line of service."

Computervision is attempting a shrewd strategy to slow the industry's

The tremendous opportunity in application-specific hardware

Distribution of electronics CAE/CAD/CAM vendors' hardware revenue



Source: The Technology Research Group

trend away from turnkey sales. The company, which used to build its computers from scratch, based its current generation of products on workstation hardware from Sun [ELECTRONIC BUSINESS April 1 p50] but added extra homemade graphics hardware to customize the systems. By adding the special hardware, CV does two things: it prevents end users from buying the workstations directly from Sun and it keeps CV's gross margins high.

The problem that faces CV today, according to the company's president Robert L. Gable, is how to adequately price the final product. "If we can manage our pricing structure where you get a fair price for each thing that's in there — a fair price for your hardware and a fair price for your applications software — then we will not have margin problems," he says.

Intergraph took CV's strategy one step further. By building its own workstation practically from scratch, Intergraph has completely locked its customers to turnkey sales. But Intergraph's strategy is risky: customers in the past have favored standard name-brand computers over proprietary hardware.

So Intergraph is hoping to establish its workstation as a standard in the marketplace by doing something it previously said it would not do: sell the workstation not only as a turnkey system but also as a standalone product sans software. The company is actively courting third parties, asking them to write software for the new workstation. Meadlock, however, denies that he is trying to turn Intergraph into a DEC-like computer company. "It's a marketplace that requires a different thrust than we have and a different level of distribution. . . . We are fundamentally in the application software business," he says. Nonetheless, Meadlock resolutely adds, "We are committed to continuing to be a vendor of both hardware and software."

MENTOR's LANGELER: "There isn't an example of a software-only supplier in this industry that has ever been successful"

Although the CAE/CAD/CAM industry is headed away from turnkey sales, Apollo's Green says that the trek is not inexorable. "I think it really depends more on the individual strength of the application package itself in that marketplace," he says. "Mentor Graphics has an exceptional and consistently strong solution and they are able to sell it on a turnkey basis. So I put the responsibility really on the solution supplier to make their product excellent. And if they do that, then they are entitled to every bit of margin that we provide them on a resell basis."

Indeed, Mentor (an Apollo OEM) apparently has had no trouble selling in the changing marketplace. Besides IBM and Intergraph, Mentor was the only other top 10 CAE/CAD/CAM company that was profitable last year, according to Daratech. Langeler says that although his company offers its software unbundled from the Apollo hardware, very few customers buy Mentor's products that way. Less than 5%, he claims. "We, No. 1, feel strategically its important to remain a *systems* supplier. And we think the market will buy that if we do our job right. If we don't do our job right, we deserve to have it go another way. But so far, our customers are not pushing too hard," he says.

David Card, associate editor, contributed to this article.

DEC: Friction with OEMs

". . . DEC is basically out of the OEM business and doesn't want to tell people . . ."

James Meadlock, president of Intergraph Corp., a DEC OEM

"We are not abandoning the OEM business . . . [but our] OEMs are going to have to start charging what their software is worth. . . . We are not going to [continue to] subsidize their [software] business with [deep] OEM discounts . . ."

Kenneth H. Olsen, president of Digital Equipment Corp.

Source: Daratech Inc.

Friction between DEC and its original equipment manufacturers has not gone unnoticed by DEC competitors Apollo Computer Inc., IBM and Sun Microsystems Inc. Dissatisfaction among some of DEC's OEMs provides those companies with an opportunity to move in, says Charles M. Foundyller, president of Daratech Inc., a market research firm located in Cambridge, Mass.

Speaking about IBM's dealings with its OEMs, Robert P. Tiel, head of a section of IBM's computer-aided engineering/design/manufacturing (CAE/CAD/CAM) efforts, says: "I would anticipate an improvement in that relationship." Some have already noticed one. "IBM's discounts are getting more and more aggressive," says Bill Green, OEM marketing manager for competing Apollo.

But Apollo itself has not exactly been dallying around either. The company last year embarked on an OEM recruiting program which included a more favorable discount schedule for new OEMs, a more forgiving order cancellation policy and an extended factory-warranty time period, among other incentives. The result: 75 new OEMs in 1986 alone.

"Fundamentally, I agree with Ken [Olsen of DEC]," says Green. "But I just think you have to provide OEMs a fair margin for buying your equipment in fair volume. I don't happen to agree with what DEC is doing in reducing their discounts . . . I've been in a number of meetings at Apollo lately and there is no general consideration going on right now in the company to reduce our OEM discounts." □

Board test meets the third wave

To the never-ending in-circuit versus functional test debate add combo testers tied to manufacturing networks

By David Card

The business of testing circuit boards is spreading out, with the high end getting higher, and the low end getting lower. This may sound obvious, but it means big changes for some of the major suppliers of automatic test equipment (ATE).

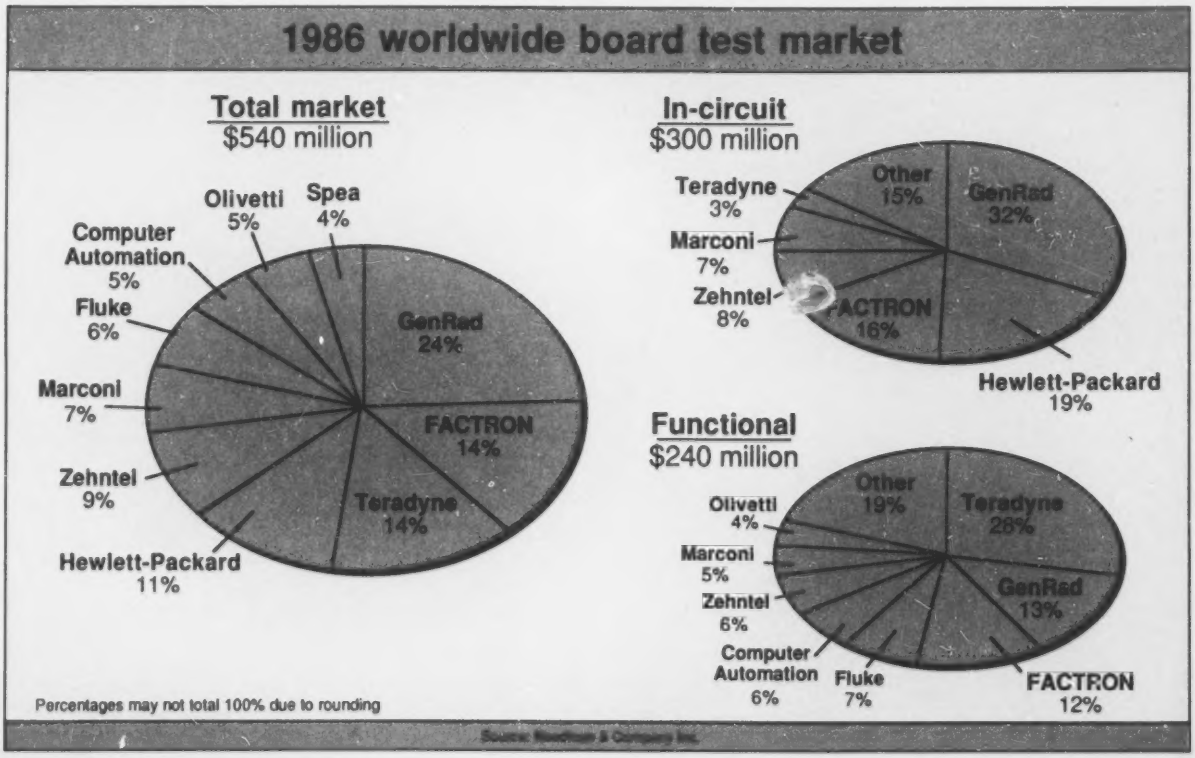
"The dominant area will be less dominant," says Kenneth Neff of market research firm Prime Data Inc. in San Jose, Calif. The majority of testers sold over the last several years employed the in-circuit method of test and cost between $100,000 and $450,000. "That middle section will wither," Neff says.

"There is a bifurcation of the traditional market," says Craig Pynn, marketing vice president of the Walnut Creek, Calif., board tester Zehntel Inc. Pynn frankly admits that Zehntel is too small a company ($10.5 million in sales in its most recent six months) to provide the emerging new spectrum of testers. Zehntel will offer low cost in-circuit testers and midrange functional models as its niche strategies, Pynn says.

In-circuit ATE tests a board by sending signals to the individual components on the board and measuring their response, on the theory that if the parts all work, the sum of them will. In-circuit testers make contact with the components through a "bed of nails" — a fixture of probes that physically connect with the contacts on the components. Functional testers plug into the board much as the board will plug into its finished system, exercising the board's functional behavior instead of its pieces. The new high-end testers, however, combine both techniques.

GenRad Inc. of Concord, Mass., is the leading supplier of in-circuit testers, commanding 32% of last year's $300 million in worldwide sales, according to New York City investment firm Needham & Company Inc. This year, GenRad is officially introducing a combinational tester, the 2750, in an assault on the high end.

In the mid-1970s, GenRad practically invented board test with its early functional models. In the early 1980s, GenRad lost the market lead in functional test to Boston-based rival Tera-



dyne Inc. This could be the year functional sales outstrip in-circuit once again, according to GenRad estimates. GenRad executives boast that the combinational 2750 is the third technology wave in board test; Teradyne sees it as catch-up. Both intend to offer a full line of technologies, as do the two other biggest players — FACTRON/Schlumberger of Billerica, Mass., and Hewlett-Packard Co.'s Manufacturing Test Division in Loveland, Colo.

The spread

"We have to be the opposite of a niche player," says J. Robert Held, vice president and general manager of GenRad Electronic Manufacturing Test's Massachusetts Division. "The market is spreading out significantly into a wider test range." Held contends that GenRad's current in-circuit strength is stable and successful, although Hambrecht & Quist Inc. analyst Carolyn Rogers says GenRad has been losing market share steadily since 1982. GenRad has lost money for seven straight quarters.

However, analyst Rogers thinks the 2750 will be a big hit and could provide GenRad with $20 million in additional sales this year. Held says he has several systems in beta-site test situations. But Held maintains the need for a wide range of testers. "Nobody at GenRad thinks the world will shift to million-dollar testers," he says. GenRad has a scaled-down in-circuit tester, as well as a $20,000 machine aimed at the service test market. But surprisingly, Held says those will not be GenRad's answer to price-conscious manufacturing test. A new architecture is required for so-called distributed testing along factory lines. Such a machine will not be a big money maker. "We'll be offering it because we want to complete the tool kit, rather than because we're going after some exciting $80 million market," Held confesses.

According to analyst Stephen Balog at Prudential-Bache Securities Inc. in New York City: "This whole trend toward lower cost, lower cost, lower cost is bad news." He does not think the test companies can handle the shrinking gross margins.

This month, Hewlett-Packard will bring out an only slightly stripped down model of its 3065 in-circuit tester costing under $120,000. "This represents a 16% per year price erosion," says test division general manager John Scruggs. But, he contends that HP *can* manage the margins since the cost cutting comes from savings in computer technology and disk drives, courtesy of HP's computer division.

HP TEST MANAGER JOHN SCRUGGS: "I see a gradual strengthening of the market this year"

But analyst Balog continues: "The basic in-circuit market is maturing, there is no question about it. And there are a number of products around the periphery taking chunks out of it." A low-grade — and cheap — tester called a manufacturing defects analyzer (MDA) is cutting into the mainstream market, explains Prime Data's Neff. MDAs are popular in Japan, and some Japanese MDA makers are starting to show up here, Neff says. MDAs catch shorts and opens in circuit boards.

> As testing occurs more locally on the manufacturing line, the characteristics of functional testers will change
>
> Arthur Buckland of FACTRON

HP recognizes the rise of the MDA, Scruggs says, especially as capital is in such short supply these days. "Our answer at this point in time is the pricing on our in-circuit testers," Scruggs says. "The demand is real, but we're going to meet [in price] somewhere down there."

FACTRON's Japanese unit, NISSEC Ltd., makes an MDA, but is not exporting it, except to a handful of big U.S. companies, including AT&T and IBM, says Arthur Buckland, FACTRON vice president and general manager. "There are fundamental changes happening in electronics manufacturing," Buckland says, "and I don't mean surface mounting components and making them smaller. That's boring — of course everything is getting smaller." Buckland says that testing must be even more of a process control than it is, with cheaper, more localized testers feeding information back to manufacturing faster. FACTRON already sells a test system that Universal Instruments Corp., a maker of component insertion equipment, incorporates into its machines.

As testing occurs more locally on the manufacturing line, the characteristics of functional testers in particular will change, Buckland says. Database management may well be more important than technical specs, he adds.

Managing the flow

GenRad's Held could not agree more. He defines GenRad's concept of a CIM (computer-integrated manufacturing) module within a factory. A series of testers with ties to design automation systems and manufacturing would be GenRad's niche. GenRad's logic and fault simulation software is at the heart of the 2750 for the design link. Yet Held made sure the software architecture of the new testers was under the control of the team that designed its manufacturing diagnosis and analysis package.

"The last thing I want to do is say to a customer, I want to manage your factory," says Joseph Lassiter, vice president and general manager of Teradyne's Manufacturing Systems Division. Teradyne has an analysis package, but is concentrating more on the design side. It has a separate design automation division to sell its simulator. The simulator, in turn, helps to generate test programs for its functional tester.

"I've got to make sure everything connects well to the LSSD [level-sensitive scan design, an IBM technique for built-in test] and scan test [same theory, but from Digital Equipment Corp.] generators owned by companies who buy our equipment," Lassiter says. Functional testers, while more thorough than in-circuit models, are notoriously difficult to program, he admits.

But Teradyne, which is pushing the high end of functional test with its

new, $3 million L290, just got into in-circuit last year. Any crossover talk is silly, Lassiter says. The reason functional testers are starting to outsell in-circuit systems is that military contractors are the traditional functional buyers, and military spending held up while the rest of electronics slumped. Anyway, he contends, it does not make any difference. "The new generation of boards won't be testable by functional or in-circuit methods, unless they're designed for testability," Lassiter says. "If they're not, there's not a damned thing I can do except maybe sell them an MDA or something."

Hewlett-Packard's Scruggs, who resells GenRad's simulator, says that simulators help in designing testable boards, but not enough. HP holds seminars and publishes guidelines for testability design. HP also has a big design automation effort. Eventually, testability could be incorporated in design software, Scruggs says, but that is a little "visionary." HP also develops fixturing kits that it sells to test service bureaus to ensure probeable boards.

> "The new generation of boards won't be testable by functional or in-circuit methods, unless they're designed for testability"
>
> Joseph Lassiter of Teradyne

An example

Tau-Tron Inc. illustrates some of these trends in board test. Tau-Tron is a roughly $50 million subsidiary of General Signal Corp. that makes telecommunications test equipment. Until a year ago, Westford, Massachusetts-based Tau-Tron did not use ATE, and some complex boards had an 80% failure rate by the time they reached final inspection, according to operations vice president Ted Miller. Final inspection consisted of plugging the board into a mock-up system.

Now, Miller says his Hewlett-Packard tester helps produce 85% success rates. But HP provided much more than just a $300,000 tester. HP invited Tau-Tron managers to visit HP plants to check out just-in-time delivery practices. Part of the price of the tester included HP personnel writing software to help Tau-Tron's design automation system — from Harris Corp.'s Scientific Calculations subsidiary — feed design data into the tester.

Miller does extensive diagnostics, using the tester's feedback of historical data stretching back sometimes as much as a year. "I walk right over to the printed circuit board people," Miller says, to work on manufacturing problems with the test results in hand. But what Tau-Tron likes best about the HP tester is its reliability — Miller says the machine was down for a grand total of only 14 hours in the year he has had it, including HP response time.

"The question is, 'Should we buy the next generation tester?'" Miller wonders, particularly to handle the custom chips starting to show up on Tau-Tron boards. "Right now, the answer is, no." Tau-Tron has instead gone with a vendor-certification program. Miller is willing to pay his chip suppliers up to 15% premium for them to do heavy testing, including burn-in, on new gate arrays. □

The board-test business forecast

Between them, they account for over 60% of the board test market, according to Needham & Company Inc. This is what the Big Four of board test have to say about the business outlook for the near term.

GenRad Inc.
J. Robert Held, vice president and general manager, Electronic Manufacturing Test, Massachusetts Division

"I have to say I see the market firm but flat. We certainly aren't banking on any recovery per se. Business will come back a little bit . . . it hit bottom last year." Held says that the Japanese market is very weak, suffering from the same general economics as the United States, but with the additional problems of the strong yen and no defense build-up.

FACTRON/Schlumberger
Arthur Buckland, vice president and general manager

"We anticipate 1987 to be flat. If it pops up, fine, but we're aiming to remain in control of our business rather than ramp up." Buckland expects that the demand for in-circuit testers will stay high because he does not expect most companies to change their manufacturing strategies overnight.

Teradyne Inc.
Joseph Lassiter, vice president and general manager, Manufacturing Systems Division

"Right now, ordering is not strong by any stretch. It varies by peaks and valleys quarter to quarter . . . . The only market growth comes from changes in ASP [average selling price] due to upgrades and market share growth." Lassiter says military spending props up the functional market, but that he is not worried about the Gramm-Rudman-Hollings budget balancer. "I don't think the electronics part of the military is very fearful," he says, because "missile silos and turbine blades" will be the victims of cuts. Some big projects may be in danger, "But how many boards going into SDI [the Strategic Defense Initiative] am I going to see in my lifetime?"

Hewlett-Packard Co.
John Scruggs, general manager, Manufacturing Test Division

"I see a gradual strengthening of the market this year, but I don't anticipate a boom year. In the first calendar quarter, we had double-digit growth over last year." Scruggs says new technologies such as surface-mounted components and custom chips are pushing test, rather than companies adding manufacturing capacity. He says the combinational in-circuit/functional segment is growing the fastest.

As usual, the analysts are more cheery than the participants. Raj Rajaratnam of Needham & Co. sees a 15% growth in the market this year. Kenneth Neff of Prime Data Inc. says, "It looks like it has bottomed out and it's firming up." Neff sees only 10% growth, but after a 10% and 5% market *shrink* in 1985 and 1986, that looks pretty good. After two years of financial and personnel restructuring, adds Stephen Balog of Prudential-Bache Securities Inc.: "If business does pick up, in general, companies are poised to make good money." □

Minisupers: A real market climbs toward $1 billion

The wedge between supercomputers and minicomputers is widening as sales move beyond R&D and into industrial systems

By Anne Knowles

Every new computer system has its doubters. It has its proponents, too, but the skeptics are usually bigger, louder and more numerous. When IBM introduced its Personal Computer in 1981, even Big Blue questioned the PC's appeal beyond a few, select users.

The doubters are especially vociferous when new technologies, and new markets, are pioneered by new companies. When Convex Computer Corp. shipped the first minisupercomputer in March 1985, the scenario was the same. Who is Convex? What is a minisupercomputer? What market is the system designed for? Does Digital Equipment Corp. (DEC) or IBM already address that market? And, if the giants haven't noticed it yet, how viable a market can it be?

Within two years, Convex, and a handful of other start-ups, provided answers to those questions. The market for minisupers exists. And they are willing and able to accommodate it. Even DEC, the most dour doomsayer of them all, no longer disputes that. "There is a role for minisupers to play," says Michael T. Peterson, a scientist with DEC's high-performance scientific computing department. "They do satisfy niche markets."

The minisuper makers would disagree. They have a role. But the market they are after is hardly a niche. The high-performance engineering and scientific market — where minisupers are sold — is currently dominated by Cray Research Inc. and DEC. At the top are Cray supercomputers, starting at $2.5 million but typically running $15 million. A quantum jump down, in both price and performance, are DEC VAXs. In addition, there are array processors — systems that attach to superminis to provide speed for compute-intensive applications — and other speciality machines, like application accelerators.

Somewhere in the middle are minisupers, comparable in price to superminis, in the $500,000 to $1 million range, and achieving about 25% the speed of a supercomputer, manufacturers claim.

Before Convex shipped its first C1 minisuper, industry analysts were already predicting that the market for minisupers would hit $1 billion by 1990. Last year, the minisuper market more than doubled, hitting $325 million, and is now expected to grow 35% compounded annually until 1991, when it hits $1.5 billion, according to Dataquest Inc., a market research firm in San Jose, Calif.

If market projections aren't enough, company revenue bolsters the outlook. Convex recorded $40.2 million in its second year of sales. After raising $32 million in venture financing, the Richardson, Texas-based manufacturer raised another $24 million through an initial public offering made in October 1986.

Other start-ups are thriving, too. Alliant Computer Systems Corp. netted $4.5 million, on $30.8 million in sales last year, also its second year of sales. Its initial public offering raised $30 million for the Littleton, Mass., company in December 1986. Scientific Computer Systems Corp., (SCS) a privately held San Diego-based company, has sold 14 systems for an average selling price of $750,000.

And others are jumping into the fray. This April, two new contenders — Cydrome Inc. and Multiflow Computer Inc. — entered the market not only with systems but with strategic alliances. Cydrome, of Milpitas, Calif., which lists Prime Computer Corp. among its investors, also boasts of having the Natick, Mass., mini maker as its first original equipment manufacturer (OEM). Multiflow, founded in Branford, Conn., by former Yale University professors, has already set up European distribution of its product through a deal with Ing. C. Olivetti & Co.

And the market is maturing rapidly. But there have also been some market setbacks. Publicly held Flexible Computer Corp., in Dallas, recently received $3.9 million in interim financing from European venture capitalists. And Culler Scientific Systems Corp., in Goleta, Calif., had to lay off employees last year.

Already two start-ups — American Supercomputer in Sunnyvale, Calif., and the computer division of Vitesse Electronics in Camarillo, Calif., — have closed their doors. Neither was able to secure enough financing to move out of the development stage. Both companies, even their competitors claim, had stable management and promising technology.

DEC's decisions

The shakeout has begun, in part, due to the fear of impending doom. DEC's acknowledgement of the minisuper market alone verifies its authenticity. But it also raises new questions. Says Steven J. Wallach, vice president, technology at Convex: "The question

asked the most is, what is DEC going to do?"

So far, DEC has responded to the market with a piecemeal strategy. In December, DEC and Floating Point Systems Inc. (FPS), the leading maker of array processors, formalized and broadened a joint-marketing deal that the two companies had had for years. DEC now bundles the VAX 8200 with FPS's M64/30 array processor and the VAX 8550 or 8700 or 8800 with the FPS M64/60. "DEC sells the whole shooting match," says Russ Doty, DEC's manager of high-performance systems.

"Cray is also working more closely with DEC to provide greater interface capability," says Jeffry Canin, an analyst with Hambrecht & Quist in San Francisco. "I wouldn't be suprised if we saw a joint-marketing agreement between Cray and DEC."

The solution provided by the FPS deal, however, already exists in the market today. The majority of FPS's processors are already installed with DEC VAXs. And the lion's share of Cray supercomputers are currently front-ended by DEC superminis. Both configurations can be, and are, accomplished independently of Cray, DEC and FPS.

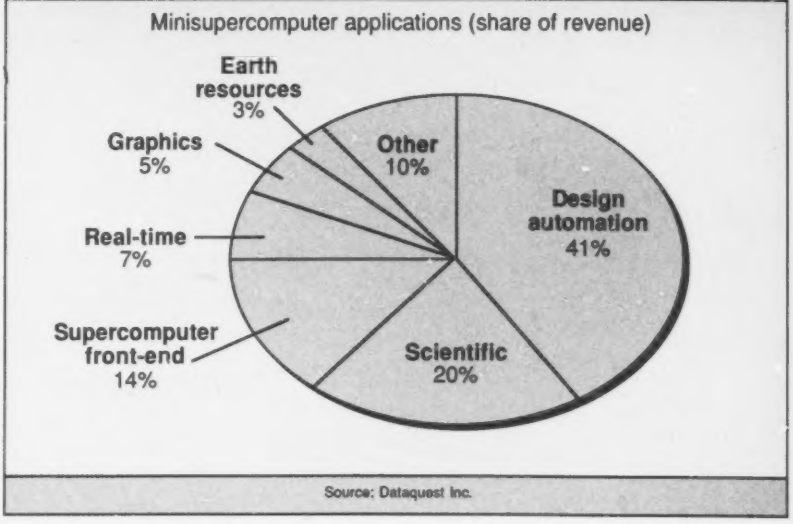
The number of Cray users is also relatively small — approximately 240 supercomputers, about 160 of which are Cray machines, are installed worldwide. The market for array processors, like FPS systems, is expected to grow about 20% annually while the minisuper market could increase by 50% this year.

DEC, say most industry analysts, is on guard. DEC disagrees. "Digital is not on the defensive," says Peterson. "We did not enter into the FPS relationship as a defensive measure." According to DEC's Doty, when the supermini maker evaluated the market, it was decided that, "it was not feasible to bring a timely [proprietary] solution to market. The conclusion was the FPS system was the best solution today."

Today, say most observers, is the operative word. "The FPS agreement is an interim strategy until DEC gets in the market on its own," says Canin. "It doesn't make sense to go through with the FPS deal if a product was imminent," agrees Convex's Wallach.

Canin, Wallach and others expect DEC will announce a VAX system incorporating vector processing, which is competitive with minisupers, within two years. DEC's reply? "Digital for a long time has been doing advanced development work on incorporating vectors into all our computers," says Peterson. "To date, evidence suggests that from a performance standpoint we are competitive and in some cases superior [to minisupers] in raw computational power with what we have to offer today."

What minisupers will be used for in 1990



Minisuper makers

DEC's announcement, if and when it comes, will have an effect on all of the players. Foremost is FPS, which stands to lose DEC's business. "FPS is aware DEC will pull out," says Hambrecht & Quist's Canin. "It gives them a two-year window of opportunity. In the meantime," says Canin, "FPS will offer greater functionality on its standalone product."

> DEC's acknowledgment of the minisuper market alone verifies its authenticity

FPS claims to have originated the minisuper market with its FPS 164 array processor, introduced in 1981. Although FPS's M64 product line, sold by DEC, can be used as a standalone system, it is optimized for vector processing and not general-purpose applications. Sales of the company's array processors and its T series supercomputer, introduced last year, have been disappointing. The T series is a parallel machine, with its largest configuration currently utilizing 128 processors, based on the Transputer, a microprocessor made by Inmos. The machine was introduced running Occam, a programming language developed for the Transputer.

Last year, the Beaverton, Ore., company laid off 450 employees, changed its management after the resignation of its president, Lloyd Turner, and posted a loss of $14 million. In 1986, says Milton R. Smith, FPS chairman and chief executive, the company also "began to perceive significant competition from Convex and Alliant."

Alliant and Convex have been in the minisuper vanguard. Convex was first to market with a minisuper system, but Alliant unveiled its FX1 and FX8 systems close on Convex's heels, in July 1985. Both reached profitability within the first year of shipping product. And both went public within months of one another.

Even though it is unfair to lump the two start-ups together — due primarily to differences in their systems architecture — both companies view the market in much the same way. Convex's Wallach and Craig J. Mundie, Alliant's vice president for software product development, envision a hierarchial world of technical computing — supercomputers at the top of the pyramid, minisupers and other speciality machines at the departmental level and workstations on the engineers' or scientists' desks.

"There will always be coexistence of special purpose, large machines as servers to workstations," agrees Michael Gallup, director of product marketing at Apollo Computer Corp. With that in mind, Apollo and Alliant entered into an exclusive OEM agreement. Apollo sells the Alliant FX series internationally. Domestically, the workstation maker also sells Alliant systems, on a nonexclusive basis. "In

the U.S. there has been more of a tendency for customers to go directly to Alliant," says Gallup.

Convex, on the other hand, signed a joint-marketing deal with both Silicon Graphics Inc. and General Electric for its Graphcon workstation. And both Alliant and Convex have joint marketing and development agreements with workstation maker Sun Microsystems Inc.

Both companies joined the Network Computing Forum founded by Apollo. Both support Sun's Network File System (NFS), for distributed data sharing. And Alliant was the first vendor to license Apollo's Network Computing System (NCS), for distributed processing.

Both companies have been quick to adopt whatever standards exist currently in the marketplace. Both run a version of AT&T's Unix operating system and both provide VMS — DEC's VAX operating system — extensions to their Fortran compilers.

David L. Micciche, Alliant's vice president for marketing, sales and services, maintains that the bulk of the company's sales have not come at DEC's expense. "One-half to two-thirds of our business last year came from the area of creating market share, not taking away market share from DEC," says Micciche. But when any minisuper is purchased, it is evaluated in conjunction with a number of other systems, including DEC VAXs.

Ray Cosner, unit chief of McDonnell Douglas's propulsion laboratory, bought a dual processor C1 XP for computational fluid dynamics applications. His department also has a Cray X-MP supercomputer and a number of DEC VAX systems. Before purchasing the C1, Cosner evaluated a VAX 8600 supermini but opted for the higher performance on the C1, despite the risk of Convex's immaturity as a company.

The Analytic Sciences Corp. purchased its first Alliant system, an FX1, to replace an FPS 164 array processor and a VAX 11/780. Since then TASC has also bought a four-processor FX8 to run a multitude of applications while the FX1 is dedicated to a single problem. But TASC has also added a VAX 8200, "to have a connection to the VMS world," says Tom Stephenson, manager of TASC's advanced computing technology department.

"The vast presence of DEC is irrefutable," says Jack Hugus, Scientific Computer Systems president and chief executive. Yet SCS has depended

CONVEX's STEVEN WALLACH: "The question asked most is, what is DEC going to do?"

on Cray compatibility to differentiate itself in the market. The SCS 40 runs the CTSS, Cray Time Sharing System, operating system. Announced a full year after Alliant and Convex started shipping, the SCS system had only 14 installations as of mid-April.

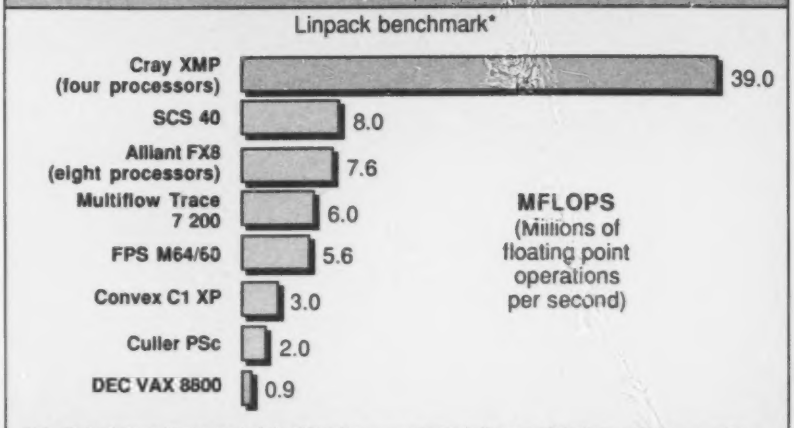
"The fact that the SCS machine ran the Cray operating system was not appealing to us," says Cyrus Cantrell, director for the center for applied optics at the University of Texas at Dallas. Despite the fact that the university uses a Cray supercomputer, the center purchased two Convex's C1 XPs. The Convex systems are utilized, in part, to write software for the Cray machine. "Cray doesn't have a workable source-level debugger," says Cantrell. Convex offered both a good debugger, says Cantrell, and "an absolutely state-of-the-art Fortran compiler."

Both Alliant and Convex have received accolades for their systems software and compilers. Alliant, in particular, has gained recognition for developing the first Fortran compiler capable of automatic parallelization.

But Convex is currently ahead in the race to provide software application packages. Both companies offer a portfolio of popular scientific and engineering packages such as Ansys, HSpice and Pisces. But Convex brought out MacNeal-Schwendler's MSC/Nastran, the most commonly used finite element analysis package, in March, while Alliant announced its intentions to port the package, which can take up to a year, in that same month. As of April, Convex had over 100 third-party software packages and is adding another 20 every quarter, according to Paul Lambert, the company's third-party product manager. Alliant, on the other hand, had 68 packages and, according to Mundie, was adding 12 to 15 packages to their catalog per quarter.

Because of its software packages,

A popular benchmark places minisupers in the middle



* The timing information presented should be in no way used to judge overall performance of a computer system since Linpack reflects one set of problems, solving dense systems of linear equations using Linpack programs in a Fortran environment.

Source: Jack Dongarra, Argonne National Laboratories

says Hambrecht & Quist's Canin, "Convex is in the lead." But both companies, says Canin, must keep driving the price/perfomance leading edge to retain their market leadership in the face of other players. If the late bloomers offer substantially greater price/performance the scene could change. "Even the Convex is too slow for us," says McDonnell Douglas's Cosner. "But it's a lot better than the VAX."

And early strategic alliances — such as Cydrome's OEM arrangement with Prime — could allow any minisuper maker to gain enough volume growth to survive an eventual shakeout. That phase of the shakeout, says SCS's Hugus, will weed out the players based not on early financing or technology, but on business practices. That may be occurring now, as the minisuper makers increasingly pitch their products to industrial customers rather than research labs.

Then DEC will jump on the field. "The first thing I'll do when DEC announces," says Convex's Wallach, "is say DEC has verified what we said all along." □

What makes a minisuper run?

Minisupercomputers, for the most part, use exotic technology similar to supercomputers. Supercomputers — defined as the fastest computers available at any given time — accomplish their breakneck speeds through various features such as custom gate arrays, pipelining and vector processing. They are also optimized for numerically intensive tasks; on general-purpose applications supercomputers are failures. But on finite element analysis, no other computer comes close.

Minisupers achieve near-supercomputer performance by using much of the same technology. They are slower, however, and cheaper, because they use many off-the-shelf components and industry standard features, like the 32-bit Multibus bus structure. Each minisuper maker, working from scratch, has created a machine of a different breed. Here are some of the approaches taken by various vendors today:

Alliant Computer Systems Corp. — Alliant's FX series of minisupers can house up to eight CEs, or computational elements. The CEs are 64-bit, custom complementary metal-oxide semiconductors (CMOS) supplied by Fujitsu. Each CE has a vector instruction set, enabling it to perform vector processing. In addition, the systems have up to 12 IPs, or interactive processors, that perform input/output functions and run the operating system, Concentrix, which is a Unix 4.2BSD implementation. The IPs are based on the Motorola Inc. 68020 32-bit microprocessor.

The FX1 has one CE and the FX8 uses from two to eight CEs. If multiple CEs are used, they can perform parallel processing — working on parts of the same program independently and simultaneously — to increase speed. The company's Fortran software compiler automatically dissects and disseminates those parts of a program that can be either vectorized or parallelized. Currently, the company also has compilers for the C programming language, and Ada, the programming language of the Department of Defense, but neither performs automatic vectorization or parallelization. Alliant expects eventually to introduce automatic compilers for both C and Ada, and a Common Lisp compiler by year end. In addition, the company plans to expand its systems to incorporate more than eight CEs.

Convex Computer Corp. — Convex's C1 series closely resembles the architecture of a Cray supercomputer. It is based on 64-bit CMOS custom gate arrays from Fujitsu. In the company's low-end C1 XL, the processors have 8,000 gates; in the high-end XP, which can contain up to four processors, the processors contain 20,000 gates.

The machines are based on both vector and scalar architecture and employ RISC (reduced instruction set computer) technology, which enables the C1's instruction set to be reduced to 95 instructions. The systems also use pipelining, originated on supercomputers, which allows data to be processed in an assembly line fashion; while one instruction is being processed, another is being decoded and a third is being fetched from memory.

Convex offers Fortran and C vectorizing compilers and plans to ship an Ada compiler by 1988. In addition, the company introduced last year what it calls the Convex Extended Supercomputing Architecture. A fiber-optic or coaxial interconnect, adhering to Token Ring standards, allows the user to connect up to 240 individual devices over a network of C1 processor nodes.

Cydrome Inc. — Cydrome's system, priced in the $500,000 to $750,000 range, is a data flow type of computer. Data flow computers use numerous processors, dedicated to a specific function, rather than one central processing unit. Both proprietary, emitter coupled logic (ECL) processors and Motorola 68020 32-bit chips are used. The system runs a version of Unix System V.

Multiflow Computer Inc. — Multiflow's system is a 64-bit computer, priced between $200,000 and $1 million, that runs a version of Unix 4.3. The company developed, and patented, a software technique called Trace Scheduling. The machine also works with very long instruction words (VLIW) of 256-bit lengths. The Trace Scheduling compiler speeds up execution of both mathematical code and "junk," or scalar, code by overlapping executions. When the first execution is initiated the compiler finds the most likely route for the next execution and puts it down that path. If that route is incorrect, the operation is sent down the next most likely path and so on until the operation is completed.

Scientific Computer Systems Corp. — The SCS-40 is most like a Cray supercomputer. It is a vector-processing system that runs CTSS, Cray Time Sharing System, a Cray compatible operating system developed at Lawrence Livermore National Laboratory. Potentially, any of the 300 software applications that run on a Cray can run on an SCS-40, although, to date, the company has contracted for only a few dozen packages. The system also emulates the Cray X-MP instruction set. □

Specific memories: A $1 billion business by 1991

Application-specific memory chips have become one of the strongest semiconductor sales segments

By Valerie Rice

Memory makers can now stop singing the "commodity blues." Application-specific memories (ASMs) have arrived, bringing with them the opportunity for higher average selling prices (ASPs), new customers and applications, as well as a completely new way to look at the memory market.

ASMs are chips which combine memory with logic, creating a product that proponents say is more powerful, versatile and cost effective than logic and memory individually. Product offerings in this area include first in/first out (FIFOs) buffers, cache-tag RAMs, video RAMs and dual-port RAMs, and are available from the likes of Dallas Semiconductor, VLSI Technology Inc., Integrated Device Technology Inc. (IDT), NEC, Texas Instruments and Vitelic Corp., to name a few.

Who uses ASMs? One industry player states, categorically, that just about anyone with a microprocessor in his system is a potential customer for these products, but the market also includes telecommunications, automobiles, the military and even toys.

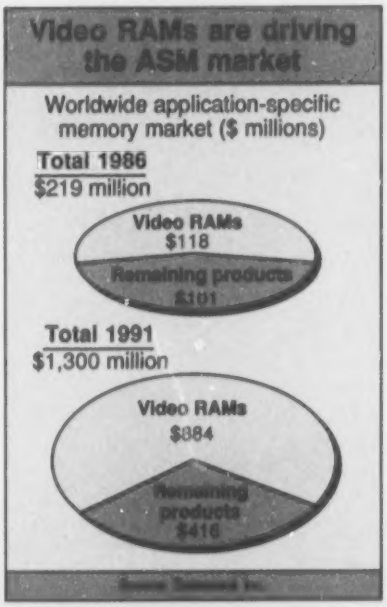
In fact Sun Microsystems Inc., Mountain View, Calif., uses ASMs in every single product it ships in the form of a video RAM in either color or monochrome displays. LSI Logic Corp. manufactures over 50% of its standard cell designs with memory included, up from 10% to 20% just five years ago. Even gate arrays with 20,000 gates and above are hard to find today without memory, according to LSI.

According to San Jose, California-based market research firm Dataquest Inc., specialty memories (the firm's name for ASMs) were a $219 million market in 1986 worldwide, and are predicted to grow to $1.3 billion in 1991. This is a compound annual growth rate of 42%, almost three times the growth rate of MOS memories as a whole, which will grow 15% during the same time frame.

The largest — and oldest — segment of the specialty memory market is video RAMs, which accounted for $118 million in 1986 (over half of the total market), and are forecasted to grow to $884 million in 1991, according to Dataquest.

Analysts credit two major forces in the market for the evolution and rapid growth of ASMs. The first is rapid increases in memory technology that have enabled designers to add functionality and depth to products; the second is end-user demand for faster, more cost-effective and unique solutions to their needs.

"Until two to three years ago, we were all bad memory builders," asserts LSI Logic Corp.'s new product development manager Richard Rasmussen. "Memories were big and sloppy, and putting them off the main board was much easier. Now memories are fast and have tight layouts and a reasonable price/performance ratio."



Also, until just recently, logic circuits received the bulk of the development attention while memory concentrated on process technology. In other words, says In-Stat Inc. vice president Bill Groves, the thrust was toward using less silicon and making higher density devices. "It was really a jelly bean business," he says.

Today memory is versatile, and when a customer wants to stand out in the crowd, he can now reach for a specialty memory product. This fact, more than anything else, will help make ASMs one of the fastest growing semiconductor markets, analysts say.

Explains Vitelic's James Koo: "The customer wants to differentiate himself and needs a product to do that. A standard memory has no changes, but if you can change the memory that provides a great deal of help." Some of Vitelic's customers come to the company wanting to "revolutionize" the industry and enhance their competitive position, Koo says. By combining logic with memory, Vitelic can create a product to do just that.

"It is really an issue of performance," says Sun's engineering vice president En Bechtolsheim. "If using a cache tag allows our systems to run 10% faster, that is a chip we'll use, because it is in the critical path of the machine. The issue is how to get to a 30MHz or faster computer. The old components have too much delay."

A specific transition

Texas Instrument's Pradeep Shah, advanced product development manager for nonvolatile memories, sees the shift to ASMs as part of the industry-wide transition to application-specific integrated circuits (ASICs). Customers are cutting their number of suppliers and are demanding more responsiveness from semiconductor vendors. "What has happened in the last three to four years is a growing

need to solve customer specific problems," he says. "We have become more customer-oriented and we want to help customers be more cost effective." Specialty memory chips, by providing users with one chip that will take the place of sometimes as many as 100 other chips, deliver users a cost and space effective solution that can give them an edge in the market, Shah says.

Users are also demanding to do things never done before, says IDT's DSP marketing manager Frank Toth. With the growing need for communications, both between systems and within various segments of the system itself, demands are being placed on semiconductors that have never before existed. "The only way to get the performance necessary is to use special memory chips," Toth says. FIFOs and dual-port RAMs, for example, have such high speed requirements that you couldn't build them any other way except on one chip, he says.

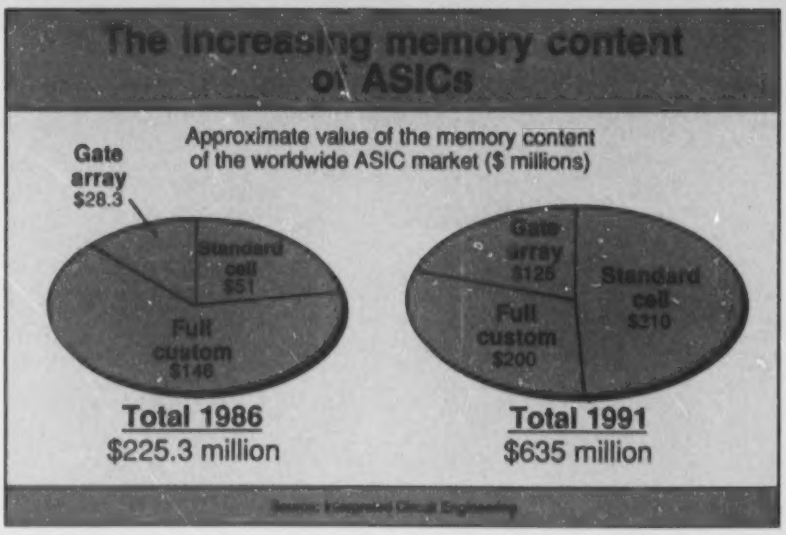
Other things have helped as well, including the dramatic growth in CAD tools, which has helped reduce the time to market for products, as well as a very real need for semiconductor companies to carve a competitive edge in the high commodity and price-sensitive memory market.

Tomorrow's commodity

However, ASMs should not be seen as a one-stop cure-all for memory woes, analysts warn. The oldest ASM, the video RAM, is practically a commodity part today, and there is tremendous competition within that market. Hitachi Corp.'s William Scharrenberg says that "one of the things we are running into is that today's ASM is tomorrow's commodity. As far as nibble mode and video RAMs: Are they ASMs or commodity? This is fast becoming a commodity market."

ASMs will also not replace standard memory parts, according to a Digital Equipment Corp. spokesman. "Our main thrust is still in the industry's standard memory areas. We do not use very many ASMs in the mainstream areas because the costs are too high. ASMs are a small piece of our overall memory usage."

In addition, ASMs are expensive, and some analysts believe that one of the largest barriers facing widespread use of ASMs is the high price point. "For use of ASMs to be really cost effective, you have to have a high volume requirement," says In-Stat's Groves. "If not, you just reach for a commodity part."



Still, ASM vendors remain optimistic and argue that as system sizes decline and the real estate within them reaches a premium, single chips that can replace large numbers of other chips with the same or faster functionality will be in high demand, regardless of the price.

Of more concern than pricing issues is the fact that much of the ASM market is populated with small companies that are breaking into the semiconductor market through niche offerings. Says VLSI ASM director and general manager Dave Handorf: "When we start seeing the Hitachis and Motorolas as competitors, we will know the market is big."

From a business standpoint, it has traditionally been the smaller players in a market which introduce a technology and take all of the risks, says market research firm Integrated Circuit Engineering's (ICE) market research manager William J. McLean. Then, when the market gets to a certain point, the larger companies step in. "If you are out with a new product every six months or so you can be one step ahead of the competition, but when you are a small company you can only do that up to a point. Once the market gets up to $300 million or so, the big companies can beat the heck out of [little companies.] Big companies let little companies break ground and design product. If it becomes a big market, they can license the technology, buy it or go into it on their own."

The head start strategy

In some cases, however, contends Dallas Semiconductor's marketing vice president Michael Bolan, first is better. "We have a two-year head start in the market," Bolan says of his cache tag and FIFO products. "It may not be so easy for large companies to take away the advantage from us." As further proof, Bolan cites Intel Corp.'s early introduction of EPROMs and its continued success in that area.

But the larger companies may have yet to really evaluate the market, Dataquest's senior industry analyst Victor DeDios believes. The smaller companies have an edge and are often the "first wave" in developing new products, he says. "We will see a wave of larger companies eventually, but everybody is still studying system applications. The smaller companies are ahead of the game in defining the market." DeDios contends that larger companies are not deterred so much by the size of the market, but by a lack of a way into the market. Once the way into the market is decided they will move.

But even ASMs are not the end of the line for memory, according to executives at Vitelic. Vitelic draws the memory "pyramid" into four segments with ASMs occupying not the top of the pyramid, as expected, but rather the high middle. Vitelic has identified a fourth memory market which executives call the customer-specific memory (CSM) market, which will provide a haven for them in case of increasing competition.

Characterizing ASMs as "off the rack tuxedos," Vitelic has labeled that next step as their custom-made tuxedos. Vitelic entered the custom business after a number of requests from customers for special memory designs. In early 1987, the CSM business became its own separate division and its plan calls for $10 million in revenue for fiscal 1988. According to marketing vice president Gary Ater, 60% of Vitelic's revenue will come from standard and ASM products this year, but next year the custom side will account for that 60%. □